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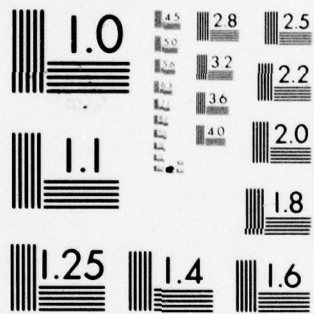
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# TAXES AND INFLATION

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## TAXES AND INFLATION

Kathy Classen Utgoff  
Frank Brechling

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## TAXES AND INFLATION

Frank Brechling  
*Northwestern University*

and

Kathleen Classen Utgoff\*  
*Center for Naval Analyses*

This paper contains the results of a preliminary investigation into the role that taxes may have played in the inflationary process of the past two decades. Such an analysis seems timely, because the proportion of GNP devoted to taxes has been rising fairly steadily since 1950.<sup>1</sup> Moreover, not much attention has been paid in the literature to taxes in the possible role as causes of inflationary pressures.

In recent macroeconomic textbooks taxes have been analyzed in a predominantly Keynesian framework, in which taxes are determinants of aggregate demand. Accordingly increases in taxes lead to reductions in aggregate demand and, hence, their impact tends to be deflationary. But aggregate supply remains completely unaffected by changes in taxes.

A radically different approach to the analysis of taxes is implied by the conventional static equilibrium theory of tax incidence. In this theory taxes are an exogenous wedge between pre-tax and post-tax factor prices. Factor supplies and demands depend on post-tax and pre-tax real factor prices, respectively. Hence, a distinction is made between pre-tax and post-tax factor supply functions. With a constant post-tax function, an exogenous increase in the tax rate shifts the pre-tax supply curve to the left if it has a positive slope and to the right if it has a negative slope. Moreover, the size of the shift depends upon the absolute magnitude of the slope of the supply function. No shift takes place when the factor supply is completely inelastic.<sup>2</sup> For the sake of brevity, let us confine our attention to the case of positively sloped factor supply curves.<sup>3</sup> In this case an instantaneous market-clearing process in factor markets raises the pre-tax and lowers the post-tax real factor prices. Further, total factor supplies decline and, hence, aggregate output falls. For expository purposes, let us postulate that the demand for money is a constant proportion of money income (so that the velocity of circulation is constant). The proportionate change in the

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aggregate price level can then be expressed as

$$\frac{dP}{P} = -E(Q,t) \frac{dt}{t} + \frac{dM}{M}, \quad (1)$$

where  $P$  stands for the price level,  $E(Q,t)$  is the elasticity of aggregate output ( $Q$ ) with respect to the tax rate ( $t$ ), and  $M$  is the money supply.<sup>4</sup> Aggregate output ( $Q$ ) may be conveniently thought of as private output, part of which is purchased by the government for the provision of public goods. The government may also use some of the taxes for lump-sum transfer payments. The elasticity  $E(Q,t)$  is negative if factor supply curves are upward sloping, if factor demand curves are downward sloping, and if the marginal products of factors are positive. Equation (1) thus shows that the price level will rise unless the quantity of money is reduced sufficiently to offset the decline in real output. Furthermore, the authorities are unable to raise output to its previous level by an expansionary monetary policy: Increases in the money supply will raise output and input prices equiproportionately and leave real factor prices unchanged. In other words, the increase in taxes has an impact on real output as well as the price level; the second can be offset by appropriate monetary policy, but the first cannot.

The differences between the Keynesian and the above classical approaches to the impact of taxes can thus be summarized as follows: In the Keynesian model, aggregate supply is fixed, taxes bear a negative relationship to aggregate demand and, hence, increases in taxes are deflationary. In the classical model, on the other hand, aggregate demand is determined by the money supply, increases in taxes reduce aggregate supply and, hence, have an inflationary impact.<sup>5</sup>

Since the role of taxes in a Keynesian model has been studied extensively, the analysis in this paper is based on the classical approach. For this purpose the classical static equilibrium theory, which has been sketched above, could be refined and developed into an equilibrium theory of the impact of taxes upon inflation. Such a theory might be similar in structure to the one presented recently by Meltzer (1977) who, however, did not consider taxes explicitly.<sup>6</sup> But the assumptions of instantaneous market clearing, the absence of money illusion, etc., makes the equilibrium model unattractive, at least, for short-run analyses. For this reason a disequilibrium version of the above model is used in this paper. The model incorporates the notion that changes in post-tax factor prices respond to excess demand conditions and changes in taxes. Most previous empirical investigators of the impact of tax changes upon money wages and output prices have also used a disequilibrium framework which is akin to the Phillips curve. Thus Perry (1970), Gordon (1971), Vroman (1974), Taub et al. (1977) and Schnabel (1978) have examined the impact of



tax changes (mainly changes in social security taxes) upon the rate of change in wages in terms of shifting Phillips curves.

We shall proceed as follows: In the second section a descriptive theoretical model is presented. This model contains (i) the quantity theory of money; (ii) a relation between changes in wages, prices, unemployment, and taxes that is similar to a short-term Phillips curve; and (iii) an expectations hypothesis. Further, in setting the rate of change in the money supply, the monetary authorities are responsive to both unemployment and inflation. In the third section some preliminary empirical evidence is presented. First, taxes are compared with other components of the net domestic product (NDP) deflator. Thereafter, the impacts of various tax changes on the NDP deflator, on after-tax incomes, and on changes in the wholesale price index are examined. The fourth section contains the conclusions of our study.

While our empirical results must be regarded as preliminary, the following tentative conclusions have emerged: First, taxes have risen faster than other components of NDP. Second, in the case of social insurance taxes, increases in the appropriately defined tax change variables seem to have exerted substantial inflationary pressures. Third, in the case of personal income taxes, on the other hand, increases in the rate of change of taxes seem to have been largely absorbed by changes in the growth of after-tax money factor incomes.

### The Model

In this section of the paper we present a disequilibrium version of the classical model sketched in the introduction. This version is similar to the theoretical framework developed by Gordon (1978). In our model, we follow the customary practice of presenting the crucial variables in disequilibrium models in terms of rates of change with respect to time. The model consists of (i) a variant of the quantity theory of money which determines aggregate demand and imposes a demand (or monetary) constraint upon inflation and output growth and (ii) a version of the Phillips curve together with an expectations hypothesis which generates inflationary pressures. Let us discuss these two components of the model in turn.

The demand for money is assumed to be a constant proportion of money income, which implies that the income velocity of circulation of money is constant and that the rate of interest plays no role in this simple model.<sup>7</sup> Thus the demand for money can be written as

$$m^d = p + q, \quad (2)$$

where  $m^d$ ,  $p$ , and  $q$  are *proportionate growth rates* in the money demand, the output price level, and aggregate real output, respectively.

The rate of change in the supply of money ( $m^s$ ) is not assumed to be exogenous. Instead, it is postulated that  $m^s$  depends negatively on the rate of inflation ( $p$ ) and positively on the rate of unemployment ( $U$ ):

$$m^s = m(p, U) \quad m_1 \leq 0, m_2 \geq 0. \quad (3)$$

According to equation (3), the monetary authorities come under political pressure when, with a given unemployment rate, inflation increases or, alternatively, when, with a given inflation rate, unemployment rises. Thus, the authorities perform a balancing act, changing  $m^s$  so as to keep inflation and unemployment within acceptable bounds.

It is convenient to relate the rate of change in output in equation (2) to the change in unemployment. For this purpose, let us consider some simple relationships between aggregate output and unemployment which are sometimes referred to as Okun's law. Suppose that there exists a stable functional relationship between aggregate output ( $Q$ ) and aggregate employment ( $N$ ), namely,  $N = f(Q)$ . When there is "full employment," this relationship is written  $N^* = f(Q^*)$ . Now define

$$\frac{N}{N^*} = \frac{f(Q)}{f(Q^*)}. \quad (4)$$

By differentiation equation (4) becomes

$$n - n^* = \epsilon q - \epsilon^* q^*, \quad (5)$$

where the lowercase letters again stand for proportionate growth rates, and  $\epsilon$  is the elasticity of employment with respect to output.

Furthermore, the unemployment rate is defined as  $U = 1 - \frac{N}{N^*}$  and, hence,  $\dot{U} = -\frac{\dot{N}}{N^*} (n^* - n) = (1 - U)(n^* - n)$  so that

$$u = \frac{\dot{U}}{1 - U} = -\epsilon q + \epsilon^* q^*. \quad (6)$$

For the sake of simplicity, let us assume that  $\epsilon^* = \epsilon$  and that  $\epsilon$  is constant. When  $m^d = m^s$ , equations (2), (3), and (6) can be rewritten as

$$m(p, U) = -\frac{u}{\epsilon} + q^* + p, \quad (7)$$

which represents the demand (or monetary) constraint upon the economy.

According to equation (7), with a predetermined  $U$  and an exogenous  $q^*$ , inflation ( $p$ ) may rise but only at the expense of raising  $u$ , namely, the rate of increase with the unemployment rate. In other words, a rise in inflation leads to a fall in real activity.

The second component of the model is a version of the Phillips curve according to which changes in before-tax money factor prices are related to excess demand conditions, expected changes in output prices, and an appropriately defined tax change variable. Let us begin with the definition:

$$W = \bar{W}(1-t), \quad (8)$$

where  $W$  is the post-tax price,  $\bar{W}$  the pre-tax price, and  $t$  is the tax rate. When equation (8) is differentiated with respect to time we obtain

$$w = \bar{w} - \frac{\dot{t}}{1-t} = \bar{w} - x, \quad (9)$$

where  $w$  and  $\bar{w}$  are proportionate changes in the factor prices, and  $x = \frac{\dot{t}}{1-t}$ .

The proportionate changes in before-tax money factor prices are postulated to depend negatively on the level and rate of change of unemployment ( $U$  and  $u$ ) and positively on the tax change variable ( $x = \frac{\dot{t}}{1-t}$ ) as well as the rates of change in actual ( $p$ ) and expected ( $p^a$ ) output prices.  $U$  and  $u$  are treated as excess supply variables which tend to have a negative influence on  $\bar{w}$ . Increases in  $x$  tend to raise  $\bar{w}$  and to reduce  $w$  because of partial backward shifting. The positive influence of  $p$  on  $\bar{w}$  may be justified by cost-of-living clauses, and finally the positive impact of  $p^a$  on  $\bar{w}$  arises from the well-known expectations hypothesis.

Output price changes can now be related to changes in factor prices, changes in taxes, and changes in the productivity of factors of production. Productivity growth is treated as exogenous in the long run and as a negative function of  $U$  and  $u$  in the short run. The above assumptions can be summarized by the following short-run Phillips relationship:

$$p = f(U, u, x) + p^a \quad f_1 \leq 0, f_2 \leq 0, f_3 \geq 0. \quad (10)$$

The influence of  $x$  on  $p$  is of particular interest. In general, it is expected to be positive, because full backward shifting of a tax increase to post-tax factor prices is unlikely. But if  $f_3 = 0$ , then such full backward shifting does take place and, hence,  $f_3 = 0$  is equivalent to completely inelastic factor-supply curves in the static equilibrium model sketched in the introduction.



To complete the specification of the model an expectation generating mechanism, which determines  $\dot{p}^a$ , has to be postulated. For the sake of simplicity, let us assume a simple adaptive process:<sup>8</sup>

$$\dot{p}^a = g(p - p^a) \quad g(0) = 0 \text{ and } g' \geq 0. \quad (11)$$

Equations (7), (10), and (11) represent a dynamic system for which  $x$  and  $q^*$  are exogenous,  $p^a$  and  $U$  are state variables, and  $\dot{p}^a$  and  $\dot{U}$  describe movements through time. Let us examine, in turn, (i) the steady-state characteristics of this system and (ii) the dynamic path described by the relevant variables.

The dynamic system represented by equation (7), (10), and (11) is in its steady state when  $\dot{U} = \dot{p}^a = 0$ , so that equations (7) and (10) become

$$m(p^*, U^*) = q^* + p^*, \quad (12)$$

$$0 = f(U^*, 0, x), \quad (13)$$

where  $p^*$  and  $U^*$  stand for the steady-state values of  $p$  and  $U$ .  $U^*$  is usually called the natural rate of unemployment. Equations (12) and (13) are illustrated in Figure 1. The line labelled  $M$  represents the relationship between  $p^*$  and  $U^*$  implied by equation (12). Since  $m_1 \leq 0$  and  $m_2 \geq 0$ , the  $M$  curve has a non-negative slope. The straight vertical line labelled  $LP$  illustrates equation (13). Since  $f_1 \leq 0$  and  $f_3 \geq 0$ , equation (13) implies that the natural rate of unemployment ( $U^*$ ) is related non-negatively to the rate of change in taxes ( $x$ ). This is an important result. Unless a rise in  $x$  is entirely absorbed by a reduction in the rate of growth in post-tax factor prices (so that  $f_3 = 0$ ), the natural rate of unemployment must rise. Moreover, an exogenous expansionary monetary policy, illustrated by the shift of the  $M$  line to  $M'$ , is incapable of reducing the natural rate of unemployment. These results are analogous to the ones stated in the introduction: In the postulated static equilibrium framework a rise in taxes leads to a fall in real output unless they are shifted backward entirely, and the monetary authorities are unable to prevent this decline in output.

Let us now turn to a brief description of the dynamic paths which  $p$  and  $U$  are likely to follow in response to an exogenous increase in  $x$ . It can be shown algebraically that the system represented by equations (7), (10), and (11) is locally stable when the partial derivatives  $m_1$ ,  $m_2 f_1 f_2$ , and  $g'$  have the postulated signs.<sup>9</sup> Let us therefore assume that the system is also globally stable. The essence of the dynamic adjustment process can be illustrated in a simple diagram. In Figure 2, let  $E_1$  represent the initial steady state. It is the intersection of three lines:  $M$ ,  $LP_1$ , and  $SP_1$ . The lines  $M$  and  $LP_1$  are the singu-



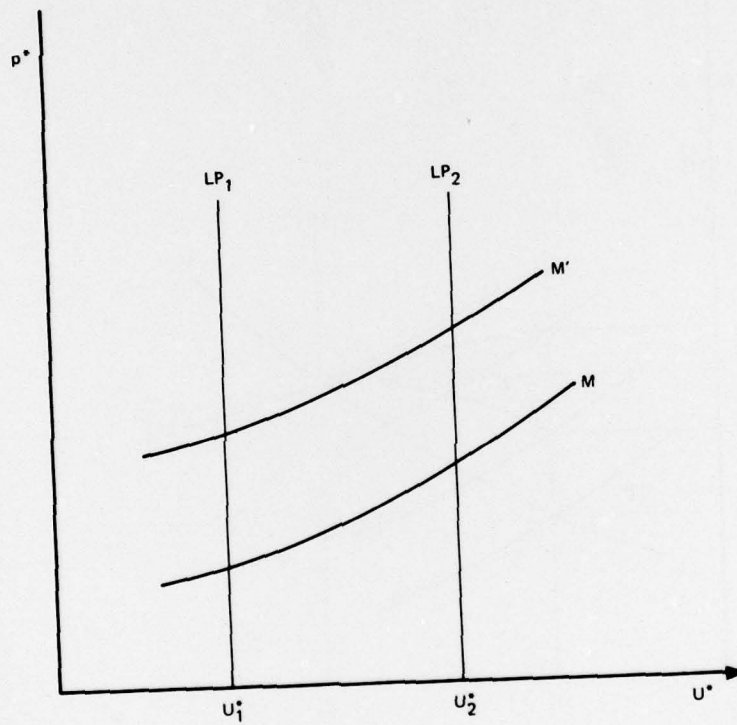


FIGURE 1

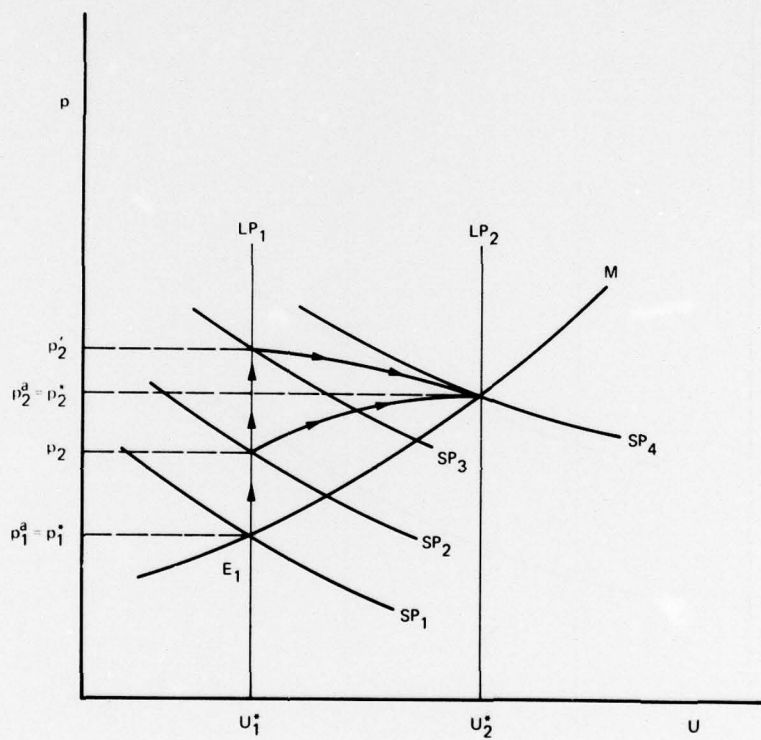


FIGURE 2

lar lines of equations (12) and (13), and  $SP_1$  is the short-run Phillips curve of equation (10). For  $SP_1$ , the expected inflation rate  $p^a$  is equal to the realized inflation rate  $p_1^*$ . A rise in  $x$  shifts  $LP$  from  $LP_1$  to  $LP_2$ , and, consequently, the steady state of the system is moved from  $(U_1^*, p_1^*)$  to  $(U_2^*, p_2^*)$ . The short-run Phillips curve moves initially from  $SP_1$  to  $SP_2$  or  $SP_3$ . Consequently, the inflation rate initially moves from  $p_1^*$  to  $p_2$  or  $p_2'$ . Since  $p_2$  and  $p_2'$  lie above the line  $M$ , the monetary constraint on the growth of money income generates an increase in unemployment. Moreover, since  $p_2$  and  $p_2'$  are above  $p_1^a$ ,  $p^a$  has to rise. Consequently  $SP_2$  and  $SP_3$  will shift further, downward because  $u > 0$  and upward because  $\dot{p}^a > 0$ . As the line  $M$  is approached,  $u$  tends to zero, but  $\dot{p}^a$  is still positive. Consequently,  $SP_2$  and  $SP_3$  must ultimately rise to  $SP_4$ , because it is only at  $(U_2^*, p_2^*)$  that both  $u$  and  $\dot{p}^a$  are zero. Two alternative hypothetical paths to the new steady state are illustrated. According to the first,  $p$  rises rapidly from  $p_1^*$  to  $p_2$ , and, thereafter, it continues to rise gradually to  $p_2^*$ . According to the second path,  $p$  rises rapidly above its new steady state to  $p_2'$  and, thereafter, declines gradually to  $p_2^*$ .<sup>10</sup> Whether or not overshooting takes place depends on the slopes of the  $M$  line and the  $SP$  lines. The steeper both the  $M$  and the  $SP$  curves are, the greater the likelihood of overshooting.

The case of a horizontal  $M$  line may be of special interest. It occurs when  $m_2=0$ , which means that the authorities do not raise  $m$  in response to increases in  $U$ . In this case, a rise in  $x$  raises  $SP$  from  $SP_1$  to  $SP_2$ , which drives up the inflation rate immediately. Thereafter, unemployment rises, and the inflation rate adjusts downward. The dynamic path may lie above or below the  $SP_2$  line. In any case, the  $SP_2$  line is appropriate in the new steady state, because the initial rate of inflation has been reestablished. In other words, under a nonaccommodating monetary policy, a rise in  $x$  leads to a temporary increase in the rate of inflation and a permanent rise in unemployment.

Discretionary increases in the rate of growth in the money supply ( $m$ ) are represented in Figure 2 by upward shifts in the  $M$  curve. Such shifts may retard for a while the movement toward  $U_2^*$ , but only at the expense of making inflation worse in the long run. In this respect, the model of Figure 2 differs from the simple static model sketched in the introduction.

The disequilibrium model of inflation and unemployment developed in this section thus implies that increases in the rate of change in taxes (that is, increases in  $x = \frac{\dot{\tau}}{1-\tau}$ ), unless they are entirely absorbed by backward shifting, lead to an increased natural rate of unemployment. Further, the rate of inflation rises immediately in response to an increase in  $x$  and, thereafter, either rises further or declines gradually to the new steady state. Moreover, the monetary



authorities may retard the movement to higher unemployment in the short run, but only at the expense of increased long-run inflation.

### Empirical Evidence

In this section of the paper, some relevant empirical evidence on the role of taxes as sources of inflationary pressures is presented. Answers will be sought for the following two questions: First, what is the evidence that various taxes have grown at rates which would represent increases in  $x$ ? According to the analysis in the second section, only *increases* in  $x = \frac{i}{1-t}$  constitute potential inflationary pressure and, hence, it must be established that  $x$  has, indeed, been rising, at least, over part of the period under consideration. Second, to what extent have increases in  $x$  been absorbed by reductions in the growth of after-tax money factor prices? For it is only the unabsorbed part of increases in  $x$  that constitutes inflationary pressure on output price changes. Many of the data which have been used in the empirical analysis have been obtained from the *National Income and Product Accounts* (available through National Bureau of Economic Research *Time Series Data Bank*). The aggregate output price index is the net domestic product deflator which can be decomposed as follows:

$$\frac{NDP}{Q} = \frac{W^*}{Q} + \frac{\Pi}{Q} + \frac{T}{Q}, \quad (14)$$

where  $NDP$  stands for net domestic product,  $W^*$  for after-tax compensation of employees,  $\Pi$  for other after-tax factor incomes,  $T$  for taxes, and  $Q$  for real output, that is, net domestic product at 1972 prices.<sup>11</sup> Taxes ( $T$ ) have been subdivided further into (i) indirect business taxes, (ii) profits taxes, (iii) personal income taxes, and (iv) social insurance taxes.

The components of the deflator in equation (14) measure the pressure of money incomes and taxes upon real output. They may thus be used as indicators of the sources of inflationary pressures. To obtain a preliminary impression of the magnitudes of the relevant variables, Figure 3 and Table 1 have been prepared. Figure 3 contains the average annual percentage growth rates over the past ten years of the four variables in equation (14). Thus, the growth rates are defined as  $r_t = 10 \ln(z_t/z_{t-10})$ , where  $z$  refers to any one of the four variables in equation (14). The time series in Figure 3 show that taxes per unit of output have tended to grow at a higher rate than the other components of the NDP deflator and that their rate of increase has been accelerating since about 1967. After-tax wages (i.e., compensation of employees) per unit of output have tended to grow much less fast than taxes, and since about 1973, the difference between the two growth rates seems to have widened.

Similar information is presented in a slightly different form in Table 1,

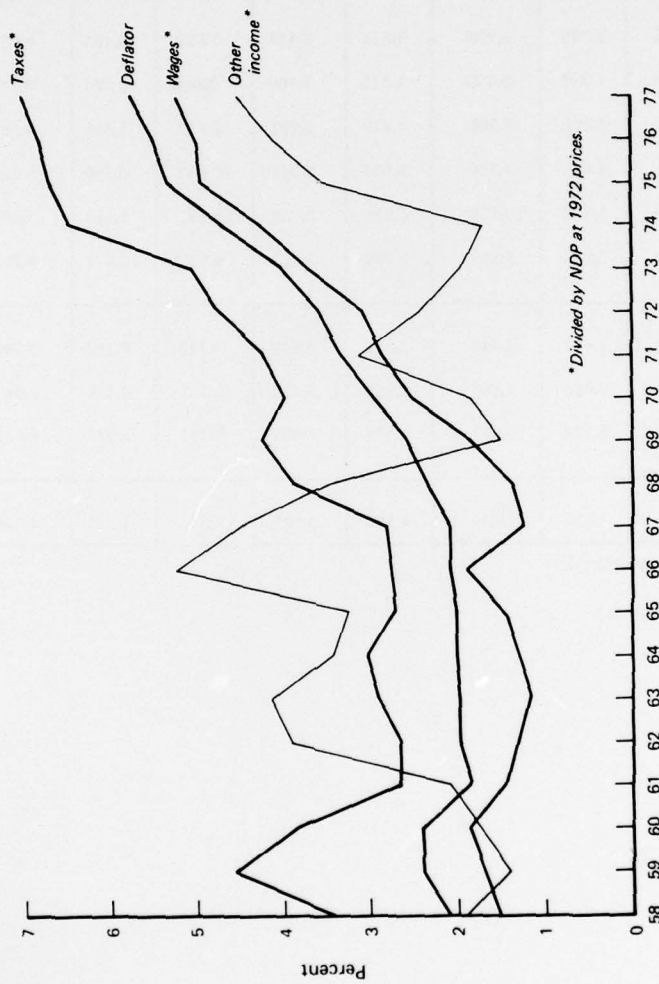


FIGURE 3

Table 1

## Average Annual Percentage Growth Rates

Period	NDP Defl.	Wages*	Other Income*	All Taxes*	Ind. Bus. Taxes*	Soc. Ins. Taxes*	Profit Taxes*	Perm. Inc. Taxes*
1950-55	2.498	1.780	3.978	3.616	2.328	5.692	0.165	6.778
1955-60	2.320	1.907	-0.490	4.133	4.569	9.848	-1.751	4.759
1960-65	1.700	0.966	7.000	1.319	1.731	2.417	1.466	0.383
1965-70	4.126	4.001	-3.384	6.681	5.344	10.617	-0.594	8.710
1970-75	6.550	5.810	10.520	6.736	5.788	10.593	5.519	5.649
1975-77	5.122	3.948	5.363	6.911	3.164	6.037	10.471	9.285
1950-60	2.410	1.843	1.744	3.875	3.448	7.770	-0.793	5.768
1960-70	2.913	2.483	1.808	4.000	3.538	6.517	0.436	4.547
1970-77	6.142	5.279	9.047	6.786	5.038	9.291	6.933	6.686
1947-77	3.042	2.436	3.199	4.190	3.677	7.501	1.583	4.426

\*Divided by NDP at 1972 prices.



which, in addition, contains the growth rates for the components of taxes (all divided by real output). It is again clear that during most of the past 30 years, taxes per unit of output tended to grow faster than the other components of the NDP deflator. In only one of the five-year subperiods (namely, 1960-65) did the deflator rise faster than taxes. It should be noted that inflation was also exceptionally low in that period. Further, after-tax wages per unit of output have risen consistently by less than the NDP deflator. Among the components of all taxes, social insurance and personal income taxes have grown particularly fast.

Next, let us examine briefly the relationship between the relevant tax variable  $x = \frac{\dot{t}}{1-t}$  and the growth rates presented in Figure 3 and Table 1. It can be shown by some simple manipulations and substitutions that  $x$  can be rewritten as

$$x = \frac{\dot{t}}{1-t} = t\left(\frac{\dot{t}}{t} - \frac{\dot{y}^*}{y^*}\right) = tA, \quad (15)$$

where  $\frac{\dot{t}}{t}$  and  $\frac{\dot{y}^*}{y^*}$  are the proportionate rates of growth in taxes and in after-tax incomes *per unit of real output*, and  $A$  stands for the difference between these two growth rates. Thus  $\frac{\dot{t}}{t}$  and  $\frac{\dot{y}^*}{y^*}$  correspond to the growth rates presented in Figure 3 and Table 1. The rate of change in  $x$  can now be determined by differentiating equation (15) with respect to time:

$$\frac{\dot{x}}{x} = \frac{\dot{t}}{t} + \frac{\dot{A}}{A} = (1-t)A + \frac{\dot{A}}{A}. \quad (16)$$

According to equation (16),  $\dot{x} \gtrless 0$  as  $\frac{\dot{A}}{A} \gtrless -(1-t)A$ . In particular, a positive  $A$  which does not decline sufficiently leads to a positive  $\dot{x}$ .

The relationships presented in equations (15) and (16) are important for the interpretation of the evidence of Figure 3 and Table 1. As has already been pointed out, taxes have typically grown faster than after-tax incomes, so that  $A$  has been positive. Furthermore, despite short-run fluctuations in  $A$ , there has been no consistent tendency for  $A$  to decline, so that the positive impact of  $A$  upon  $\dot{x}$  is unlikely to have been offset by sufficiently small values of  $\dot{A}$ . Indeed, in recent years,  $\dot{A}$  seems to have been positive, thus giving an additional positive impetus to  $\dot{x}$ . We conclude, therefore, that the evidence of Figure 3 and Table 1 suggests fairly strongly that the tax push variable ( $x = \frac{\dot{t}}{1-t}$ ) in the theoretical model of the previous section has indeed been rising for most of the past 30 years. Such increases in  $x$  are necessary if taxes are to have contributed to the inflationary process of recent decades.

Although the evidence of Figure 3 and Table 1 is suggestive, it does not

allow us to answer specific questions about the impact of taxes upon inflation. For instance: How large are the inflationary impacts of the recent increases in social security taxes? To answer such and similar questions, we must estimate an appropriate model empirically and then ascertain the impact of tax changes on after-tax factor incomes as well as on output prices.

The model which has been used for empirical purposes is quite similar to the theory sketched in the previous section of this paper. In that theory, the following variables are treated as endogenous: (i) changes in output prices ( $p$ ); (ii) changes in after-tax factor prices ( $w$ ); and (iii) changes in unemployment ( $u$ ). The exogenous or predetermined variables are: (i) changes in the rate of increase in taxes ( $x$ ); (ii) the long-run growth of output ( $q^*$ ); (iii) productivity growth; (iv) the unemployment rate ( $U$ ) and expected inflation ( $p^a$ ) as state variables. The reduced forms of the model relate each of the three endogenous variables to all the exogenous ones.

Two different sets of empirical investigations of the effects of tax changes on inflation have been undertaken. In the first, standard national income and product account data were analyzed; in the second, the determination of the rate of increase in manufacturing wholesale prices was examined. Let us discuss these two investigations in turn.

For the analysis of the national income and product account data, the following definitions and assumptions have been adopted: First, the change in output price is defined as  $\Delta \frac{NDP}{Q}$ , namely, the first difference in the  $NDP$  deflator. Second, after-tax factor price changes are defined analogously as  $\Delta \frac{W^*}{Q}$  and  $\Delta \frac{\Pi}{Q}$ . This approximation is valid because productivity growth is assumed to be exogenous. Third, the measure of excess demand ( $U$ ) has been supplemented by other measures of the gap between actual and potential output. Specifically, the deviation of real  $NDP$  ( $Q$ ) from its time trend and first differences in real  $NDP$  have been introduced. Fourth, changes in taxes have been defined as  $\Delta \frac{T}{Q}$ . This procedure implies the assumption that  $T$  is exogenous in spite of the fact that, with a given tax rate structure,  $T$  tends to rise with the tax base.<sup>12</sup> In the case of the social insurance taxes, however, the difficulties associated with this assumption may have been overcome by a two-stage procedure described below. Fifth, in order to allow for inflationary expectations in the empirical model, lagged price changes (that is, lagged  $\Delta \frac{NDP}{Q}$  variables) have been introduced.

As a result of these assumptions and definitions, the reduced forms of the model relate  $\Delta \frac{NDP}{Q}$ ,  $\Delta \frac{W^*}{Q}$  and  $\Delta \frac{\Pi}{Q}$  to current and lagged unemployment,

current and lagged real  $NDP$ , a time trend, current and lagged values of  $\Delta \frac{IBT}{Q}$  (indirect business taxes),  $\Delta \frac{PROF}{Q}$  (profits taxes),  $\Delta \frac{IT}{Q}$  (personal income taxes), and  $\Delta \frac{INS}{Q}$  (social insurance taxes).  $INS$  includes both the employers' and the employees' shares of social insurance taxes.<sup>13</sup>

Since the tax variables depend partially on factor incomes, there is a possibility of simultaneous equation bias. In the case of social insurance taxes, it is, however, possible to remove such bias by means of the following two-stage procedure. In the first stage,  $\Delta \frac{INS}{Q}$  is fitted to (i) changes in wages and salaries per unit of output ( $\Delta \frac{WS}{Q}$ ), (ii) changes in the taxable wage bases of both the social security (FICA) and the unemployment insurance taxes (FUTA) per unit of output ( $\Delta \frac{SOCB}{Q}$  and  $\Delta \frac{UIB}{Q}$ ), and (iii) changes in the social security and unemployment insurance tax rates ( $\Delta t_s$  and  $\Delta t_{ui}$ ). In the second stage, the predicted value of  $\Delta \frac{INS}{Q}$  is then used in lieu of its actual value.

The first stage was estimated by a linear OLS equation. It turned out as follows:

$$\begin{aligned} \Delta \frac{INS}{Q} = & 0.000035 + 0.09991 \Delta \frac{WS}{Q} + 0.00178 \Delta \frac{SOCB}{Q} \\ & (0.45) \quad (9.60) \quad (11.05) \\ & + 0.00151 \Delta \frac{UIB}{Q} + 0.00674 \Delta t_s + 0.00259 \Delta t_{ui} \quad (17) \\ & (2.51) \quad (14.86) \quad (4.40) \\ R^2 = & 0.878 \quad D-W = 1.98 \end{aligned}$$

The numbers in parentheses are  $t$ -ratios. The above equation was estimated with quarterly data for the period 1950:1 to 1977:4 (112 observations).  $INS$ ,  $WS$ , and  $Q$  are seasonally adjusted figures from the *National Income and Product Accounts*. The data for the tax bases and rates have been obtained or computed from figures given in various official social security and unemployment insurance publications. Equation (17) suggests that the exogenous changes in the two taxable wage bases and in the two tax rates contribute very significantly to an explanation of changes in social insurance taxes. All the coefficients have the appropriate positive signs and are highly significant by the usual standards.

The results of the three, two-stage regressions used to estimate the impact of taxes on the deflator and factor incomes are given in Table 2. For the sake of brevity, only the tax coefficients are presented. The evidence in Table 2 can be summarized as follows: First, changes in social insurance taxes have a strong and immediate positive impact on the  $NDP$  deflator and a smaller



Table 2

The Impact of Taxes on the Deflator and Factor Incomes  
(t-statistics in parentheses)

Dependent Variable	Lag	$\Delta \frac{IBT}{Q}$	$\Delta \frac{PROF}{Q}$	$\Delta \frac{IT}{Q}$	$\Delta \frac{LVS}{Q}$
$\Delta \frac{NDP}{Q}$	0	0.357 (0.81)	0.442 (2.64)	0.099 (1.24)	0.970 (3.82)
	-1	0.157 (0.37)	0.238 (1.32)	-0.0001 (-0.002)	0.163 (0.63)
	-2	0.352 (0.84)	0.325 (1.72)	-0.011 (-0.14)	0.054 (0.22)
	-3	-0.090 (-0.22)	0.137 (0.74)	0.013 (0.16)	0.274 (1.08)
	-4	-0.433 (-1.01)	0.154 (0.90)	-0.010 (-0.14)	-0.477 (-1.86)
	SUM	0.343	1.296	0.090	0.984
$\Delta \frac{W^a}{Q}$	0	0.809 (1.96)	0.122 (0.78)	-0.655 (-8.76)	-0.101 (-0.43)
	-1	0.928 (2.32)	-0.002 (-0.01)	0.103 (1.43)	0.172 (0.72)
	-2	0.186 (0.48)	0.211 (1.19)	-0.154 (-2.12)	-0.426 (-1.81)
	-3	0.172 (0.46)	0.212 (1.23)	0.086 (1.19)	0.209 (0.88)
	-4	0.082 (0.20)	-0.131 (-0.82)	0.042 (0.62)	-0.182 (-0.76)
	SUM	2.176	0.412	-0.578	-0.329
$\Delta \frac{\Pi}{Q}$	0	-1.485 (-3.52)	-0.618 (-3.87)	-0.253 (-3.32)	0.123 (0.51)
	-1	-0.913 (-2.24)	0.238 (1.39)	-0.099 (-1.35)	0.002 (0.01)
	-2	0.275 (0.69)	0.106 (0.59)	0.158 (2.12)	0.441 (1.84)
	-3	-0.169 (-0.44)	-0.084 (-0.48)	-0.078 (-1.05)	0.092 (0.380)
	-4	-0.462 (-1.13)	0.315 (1.92)	-0.047 (-0.68)	-0.407 (-1.66)
	SUM	-2.754	-0.043	-0.320	0.252

negative impact on wage income. Second, income taxes appear to be absorbed almost entirely by reductions in after-tax wages and other factor incomes. Third, the impact of profits taxes falls largely on the NDP deflator; early declines in other incomes are recouped. Fourth, indirect business taxes have little impact on the deflator; an increase in business taxes results in an increase in wages and in a reduction in other income.

The results presented in Table 2 thus suggest that only two tax changes seem to have a strong influence on inflation, those in profit taxes and those in social insurance taxes. In view of the recent legislation specifying substantial increases in social security taxes in the next few years, let us illustrate the impact of such tax increases on inflation. For this purpose, we have computed the increase in the first difference of the NDP deflator which would have occurred in the fourth quarter of 1977, had there been a \$1000 increase in the tax bases of the social security and unemployment insurance taxes or a one percentage point increase in the tax rates. The percentage point increases in the first difference of the NDP deflator turned out as follows:

<u>Tax Change</u>	<u>Percentage Point Change in Deflator</u>
$\Delta SOCB = \$1000$	0.1405
$\Delta UIB = \$1000$	0.1192
$\Delta t_s = 1\% \text{ point}$	0.6538
$\Delta t_{ui} = 1\% \text{ point}$	0.2513

At the end of 1977, the actual changes in the tax parameters were  $\Delta SOCB = \$1200$ ,  $\Delta UIB = \$1800$  and  $\Delta t_s = 0.2$  percentage points.<sup>14</sup> With the above coefficients, these changes would have raised the increase in the NDP deflator by a total of 0.51 percentage points. This should be compared with an actual change of 2.48 points in the first quarter of 1978. Moreover, at the beginning of 1979,  $SOCB$  rose by another \$5200 and  $t_s$  by 0.08. According to the above number, these changes might raise the increase in the deflator by 0.80 percentage points.

In the second set of investigations to be reported here, the rate of change in wholesale prices of various manufacturing industries was treated as the dependent variable. The following were treated as excess demand variables: national unemployment; unfilled orders and inventories in relation to shipments and real shipments as deviations from their time trend. The three stocks refer to the beginning of the quarter, and values for the current and previous quarters

Table 3

The Impact of Tax Variables on Rate of Increase in Wholesale Prices  
(t-statistics in parentheses)

	Lag	Industry		
		Total Manufacturing	Durable Goods Industries	Nondurable Goods Industries
	0	0.000263 (1.32)	0.000171 (0.86)	0.000370 (1.17)
Change in Social Security Tax Base*	-1	0.000309 (1.52)	0.000441 (2.11)	0.000085 (0.26)
	-2	0.000277 (1.30)	-0.000131 (-0.60)	0.000587 (1.86)
	0	0.00971 (1.80)	0.00491 (0.90)	0.01441 (1.63)
Change in Social Security Tax Rate	-1	0.01052 (1.86)	0.00644 (1.08)	0.01316 (1.58)
	-2	-0.00290 (-0.52)	-0.01345 (-2.36)	0.00368 (0.39)
	0	-0.4476 (-0.60)	1.4214 (1.77)	-1.7895 (-1.70)
Change in Indirect Business Tax Rate	-1	0.7773 (1.18)	0.1280 (0.19)	1.5610 (1.54)
	-2	0.7683 (1.04)	0.0666 (0.09)	1.1526 (0.98)
	0	0.06595 (0.53)	0.06553 (0.49)	0.06456 (0.32)
Change in Income Tax Rate	-1	0.01912 (0.16)	0.15232 (1.31)	-0.04451 (-0.21)
	-2	-0.12438 (-1.00)	0.03683 (0.31)	-0.16531 (-0.81)

\*The coefficients of the change in the tax base are multiplied by 100.



were used for all four variables. Moreover, the change in import prices in the current and previous quarters was used as an additional explanatory variable.<sup>15</sup>

Initially, all the relevant tax variables were used as independent variables. It turned out, however, that the number of explanatory variables had become too large to yield significant coefficients. For this reason the tax variables which had insignificant coefficients more or less consistently were omitted from the regressions. The remaining tax variables are: (i) the change in the social security tax base; (ii) the change in the social security tax rate; (iii) the change in the indirect business taxes as a proportion of NDP; and (iv) the change in the average income tax rate. Although the wholesale price index and some of the other explanatory variables refer to manufacturing industries, all the tax variables refer to the economy as a whole.

The regression coefficients of the four tax variables in the equations for total manufacturing, durable goods industries, and nondurable goods industries are presented in Table 3. The regression equation was fitted also to 10 two-digit manufacturing industries. The number of positive and negative signs together with the number of significant coefficients are presented in Table 4.

Table 4  
Signs of Regression Coefficients for Ten Two-Digit Manufacturing Industries

	Number of Positive Signs		Number of Negative Signs	
	Total	Significant*	Total	Significant*
Change in Social Security Tax Base	25	8	5	0
Change in Social Security Tax Rate	11	1	19	1
Change in Indirect Business Tax Rate	17	1	13	2
Change in Income Tax Rate	23	3	7	1

\*For a significant coefficient, the absolute value of the *t*-statistic is equal to or greater than 1.5.

The evidence of Tables 3 and 4 can be summarized as follows: First, increases in the social security tax base tend to have a positive impact on the rate of increase in the wholesale price index. This conclusion is well supported by the evidence for both the industry aggregates (Table 3) and the two-digit industries (Table 4). Second, the effects of increases in the social security tax rate are rather less certain. For total manufacturing and nondurables, it is positive. But for durables and many of the two-digit industries, a substantial number of (mostly insignificant) negative signs have been estimated. Third, the effects of changes in the indirect business tax rate are also uncertain. No dominant pattern seems to emerge from either Table 3 or Table 4. Fourth, the effects of increases in the income tax rate are interesting. For the industry aggregates, changes in the income tax rate seem to have no impact on the rate of increase in the wholesale price index. This result is consistent with the earlier finding according to which changes in income taxes seem to be shifted backward almost entirely. But the numbers of Table 4 suggest that in the two-digit industries, the coefficients are predominantly positive, though only a few are significant.

Let us again illustrate the inflationary impact of changes in the parameters of the social security tax system by using the estimated coefficients for total manufacturing. As has already been mentioned, the social security tax base was raised by \$1200 and the tax rate by 0.20 percentage points at the end of 1977. The estimated inflationary impact of these changes is illustrated in Table 5.

Table 5  
Estimated Inflationary Impact of Social Security Tax Change at End of 1977

Period	Actual Increase in Prices (%)	Due to Rise in Tax Base	Due to Rise in Tax Rate	Due to Rise in Base and Rate	Proportion of Actual Due to Rise in Base and Rate
1977:4-1978:1	1.96	0.3156	0.194	0.5096	0.26
1978:1-1978:2	2.41	0.2708	0.210	0.5808	0.24
1978:2-1978:3	1.69	0.3324	-0.058	0.2744	0.16

The second column contains the actual percentage rate of increase of wholesale prices. The third and fourth columns show the amount of increase attributable to the rise in the base and the rate, and the fifth column contains their sum. Column 6 shows that about one-fifth to one-fourth of the actual increase in

prices may have been caused by increases in the tax base and rate. These results are not very different from the previously reported finding that 0.51 points of the 2.48-point rise in the NDP deflator may be attributable to increases in the relevant tax parameters.

### Summary and Conclusions

In this paper we have presented a preliminary analysis of the relationship between tax changes and inflation which is radically different from the Keynesian approach common to most macroeconomic textbooks. In the Keynesian model, tax changes have a negligible impact upon aggregate supply. They affect primarily aggregate demand. Thus, an increase in taxes leads to a reduction in aggregate demand and, hence, it is deflationary. In the static classical model, on the other hand, aggregate demand is determined by the money supply. Unless all factor supplies are inelastic (or downward sloping), a tax increase tends to reduce aggregate supply and, hence, it is inflationary.

In the second section of this paper, a disequilibrium version of the static classical model has been presented. It consists of a kind of Phillips curve with an expectant hypothesis and a monetary constraint. According to this model an increase in  $x = \frac{i}{1-t}$  (where  $t$  is the tax rate) tends to lead to an increase in both the long-run (natural) unemployment rate and the long-run inflation rate. In the short run, the model is stable. In response to a rise in  $x$ , the unemployment rate tends to rise to its new long-run level, but the inflation rate may rise temporarily above its new long-run level and then return to it. An expansionary monetary policy may retard the movement to the new long-run level of unemployment but only at the expense of creating an increased long-run inflation rate.

In the third section of this paper, the results of some simple tests of the disequilibrium version of the classical model have been presented. The rates of increase in both the NDP deflator and the wholesale prices in manufacturing have been found to be positively associated with increases in the relevant social insurance tax parameters. It seems that the changes in the social insurance tax parameters which went into effect at the end of 1977 may have been the cause of about 20 to 25 percent of the actual inflation which occurred in the beginning of 1978. By contrast, changes in neither income taxes nor indirect business taxes seem to have had a strong influence upon the rate of inflation. The evidence on the effects of changes in profits taxes is mixed.

Within the theoretical framework postulated in the second section of this paper, increases in  $x = \frac{i}{1-t}$ , brought about by legislated changes in the



parameters of social insurance taxes, thus, tend to raise the long-run (natural) rate of unemployment and possibly also the long-run rate of inflation. In contrast, other tax changes seem to be shifted backward to a substantial extent.

The differences in the impacts of social insurance and income taxes is somewhat puzzling. Some investigators (see, for instance, Crandall, 1978), seem to attribute it to the fact that part of the social insurance taxes are levied initially upon employers. But such an argument is theoretically most unsatisfactory. At most, it can be valid only for the short run.

An alternative, somewhat Keynesian, explanation for the apparent differences between the inflationary impact of income tax and social insurance tax changes can be described as follows (see Blinder, 1973): Increases in income taxes are usually not accompanied by increases in government spending. In contrast, social insurance taxes are raised specifically to pay for increased social insurance benefit outflows. Consequently, the former may lead to a decrease in aggregate demand, while the latter may leave aggregate demand more or less unaffected. In terms of Figure 2, a rise in  $x = \frac{i}{1-t}$  due to income taxes is associated with a downward shift of the  $M$  line, while  $M$  is unchanged when the rise in  $x$  is caused by social insurance taxes. In both cases, the natural rate of unemployment rises, but the associated inflation is less in the first than in the second case.

The relevance to economic policy issues of the kind of theoretical and empirical research discussed in this paper is obvious. For instance, it has been suggested that the proposed increases in social security taxes be reduced and the benefits be financed from general revenues (see, for instance, Crandall, 1978). Further, the various versions of the tax-based incomes policies rest on assumptions about backward and forward shifting of taxes (see Seidman, 1978). These proposals have been derived primarily from theoretical arguments. It seems that reliable empirical information on the impact of tax changes is highly desirable for an evaluation of these and similar policy proposals.

While no finality is claimed for any of our theoretical and empirical results, we believe that an analysis of tax increases as possible causes of inflationary pressures is long overdue. We hope that our study represents a first step in such an analysis.

# Notes

1. For evidence on this point, see Figure 3 and Table 1.
2. Let  $N^s = f(\frac{\bar{W}}{P}(1-t))$  be a factor-supply function where  $N^s$  is the quantity supplied,  $\frac{\bar{W}}{P}$  is the real factor pre-tax price, and  $t$  is the tax rate. Since  $\frac{\partial N^s}{\partial t} = -f' \frac{\bar{W}}{P}$ , the supply curve shifts to the left or to the right in response to a rise in  $t$  according to whether  $f'$  is positive or negative.
3. In the case of labor a negatively sloped supply function may occur because the income effect dominates the substitution effect. If, however, hours of work are fixed, the income effect is suspended. Further, if increased taxes are accompanied by the provision of increased government services, which can be treated like an increase in real income, then the income effect is weakened. These two arguments reduce the likelihood of a negatively sloped labor supply curve.
4. The basic conclusion of equation (1) can be obtained also from a model with an interest rate (and, hence, variable velocity of circulation). Consider, for instance, Patinkin's (1965) aggregate model. The commodity-market-clearing equation has a negative slope and the money-market-clearing equation a positive slope in interest-price space. A *ceteris paribus* decline in real output raises the former and lowers the latter. Thus the equilibrium price level must rise, but the rate of interest may rise or fall.
5. Blinder (1973) presents a nice exposition of the static demand and supply effects of taxes in Keynesian and classical models. But he does not deal with the disequilibrium approach to be developed in the second section of this paper.
6. Meltzer (1977) did, however, introduce the rate of change in government employment as one of the determinants of inflation and found empirically that it had a predominantly positive impact. This variable may be quite similar to the rate of change in taxes. It should also be pointed out that Meltzer does allow for disequilibrium situations by distinguishing between anticipated and realized variables.
7. The above simple quantity theory approach may not be appealing to some readers. We are confident, however, that a more sophisticated approach to the demand for money would not affect the basic predictions of the model.
8. The above adaptive process may, of course, be instantaneous. In that case, expectations would be rational in the present model. The dynamic adjustment illustrated in Figure 2 would, however, not become instantaneous. The growth in unemployment would remain gradual. Hence, the above adaptive process includes rational expectations as a special case.
9. In  $p^a-U$  space, the expansion of the system about its steady state yields
 
$$\dot{u} = \frac{1}{D} [f_1(1-m_1) - m_2] [U-U^*] + \frac{1}{D}(1-m_1) (p^a - p^{a*})$$

$$\dot{p}^a = \frac{1}{D} [g_1 \frac{1}{\epsilon} - p_2 m_2] [U-U^*] + \frac{1}{D} [g' f_2(1-m_1)] (p^a - p^{a*}),$$
 where  $D = f_2(m_1 - 1) + \frac{1}{\epsilon} \geq 0$ . It can easily be shown that, on the stated assumptions, the trace of the adjustment matrix is negative, and its determinant is positive. This is sufficient for local stability.
10. It should be emphasized that the two paths are hypothetical alternative approaches to the new steady state. In fact, the two models generating  $SP_2$  and  $SP_3$  should have different steady states.
11. For the computation of after-tax factor incomes, factor incomes net of all but personal income taxes were adjusted downward by using the average income tax rate for all types of incomes.
12. A basic shortcoming of the ensuing empirical work is related to the simultaneous equations bias which may arise because the rate of increase in income taxes must be expected to rise with inflation, particularly but not only because of the progressive income tax structure. Thus, according to

the theory of the second section of this paper a rise in the rate of increase in income taxes should raise the rate of inflation, but according to the above argument the cause-effect relationship is reversed. In both cases, however, the relationship should be a positive one. The evidence in Tables 2 and 3 suggests, however, that there is not a strong association between the rate of increase in income taxes and inflation. Hence, this simultaneity problem was not pursued further. An appropriate treatment of income taxes ought to be similar to the two-stage procedure used above for social insurance taxes.

13. In initial experiments social insurance taxes were broken into employer and employee shares. Since, however, the social security tax shares are equal, the two series are highly colinear. Hence, they were aggregated. Furthermore, in theory it does not matter, except possibly in the short run, who pays the tax in the first instance.
14. The unemployment insurance tax ( $t_{ui}$ ) rate also rose at the end of 1977, but the magnitude of the rise cannot yet be established.
15. Lagged changes in the wholesale price index were also used initially to account for the expectations hypothesis. But their coefficients were insignificant and, hence, they were omitted from the equations.



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